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Introduction
Chapter 1

Wolfgang Nentwig[1], Melanie Josefsson[2]

1 *Community Ecology, University of Bern, Baltzerstrasse 6, CH-3012 Bern, Switzerland* **2** *Swedish Environmental Protection Agency, c/o Department of Environmental Monitoring, P.O. Box 7050, SE 750 07 Uppsala, Sweden.*

Corresponding authors: *Wolfgang Nentwig* (wolfgang.nentwig@iee.unibe.ch), *Melanie Josefsson* (melanie.josefsson@snv.slu.se)

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Dispersal of organisms is among the most important conditions that has enabled the development of life on earth and the high diversity of species we encounter today. This natural process is guided by biogeographical barriers which subdivide the accessible space of the Earth into compartments: species are limited to islands, summits, lakes, or oceans and shorelines, mountain ridges or climate zones. Such natural boundaries reduce competition, create conditions for speciation, and form the basis for the evolutionary centre where a given species has originated. This species is then **native** (indigenous) to this area.

These natural biogeographical barriers have increasingly been overcome by human dispersal and humans now inhabit all parts of the world. This process of human dispersal started in Africa more than 100,000 years ago, and is an intrinsic part of human history. At first, this slow but continuous conquest was performed by walking, at the natural speed of humans, and was limited by the physical condition of individuals. The speed of movements increased in the last centuries and today, we can reach virtually any spot on earth by airplane within 24 h. The turning point was certainly, when sailing ships circumnavigated the world and connected continents. With such big carriers, mass transportation of materials, animals and plants over large distances was also possible.

Christopher Columbus was the second European in the New World (the first discovery of North America by the Vikings some 500 years earlier had no long-lasting consequence, other than the introduction of the North American bivalve *Mya arenaria*

to Scandinavia in the 1200s (Petersen 1992), and with him the global race duel to connect all parts of the world faster and tighter began. Thus, the year 1492, when Columbus set foot on the first Caribbean island was the starting point of this self-accelerating process later called globalisation.

This process had serious consequences because man did not travel alone. His entourage comprised crop plants and domesticated animals and pets, including all the pests, pathogens and parasites which usually adhere to them. In other words: in the last 500 years hundreds and thousands of species have been spread worldwide both intentionally and unintentionally. Through this human aided spread the biogeographical barriers have become more and more permeable and more and more species are no longer restricted to their native areas.

Species living outside of their natural range and outside of their natural dispersal potential are **alien species**. Their presence in the new habitat is due to intentional or unintentional human activities and without this human support they would never have reached their new area. Thus, there is an important difference between natural dispersal of species that, e.g., allows Mediterranean species to spread north of the Alps because the summers are becoming warmer and man-mediated transport of American, African, Asian or Australian species which then suddenly show up in European harbours or airports and disperse into the hinterland. These last species are called **alien *to* Europe**. Obviously, species of European origin may also be translocated by man outside of their natural range, e.g. Mediterranean species to Northern Europe or species of continental Europe to Atlantic and Mediterranean islands. In this case, they are called **alien *in* Europe**. However, in many cases it appears highly difficult to disentangle the effect of human-mediated transport from that of natural dispersion when a native European species is suddenly found outside its range.

But why is it disadvantageous to increase the number of naturally occurring species (the native fauna and flora) by some alien species? In most (if not all) natural ecosystems the given set of species is the result of a long adaptation and co-evolution to the physical and biotic environment. The higher the natural biological diversity is, the greater the biotic resistance is against additional, foreign species. If ecosystems are disturbed (e.g. by fire, flooding or erosion) or are artificial ecosystems (such as agricultural habitats or urban areas), alien species have a much higher chance to establish.

An alien species will interact with resident species or the abiotic environment in a different manner than a native species and therefore such an additional species is usually neither an enrichment of the ecosystem nor any amelioration of a process. Alien species are usually somehow different from the resident species since they have evolved in a different environment. They may represent a new type of predator, they may have novel weapons, or they may have other new properties which may enable them to alter habitats or even ecosystem functioning. They can fill hitherto empty niches, they may change matter flux or impact energy flow. Such changes affect the resident species most often in a negative way and native species may become less common or even disappear. At this stage, the alien species impacts the invaded ecosystem and becomes an **invasive**

species. Usually the term "alien" is used in the sense of "not wanted here" but calling it invasive is a clearly negative attribute.

The consequences of an alien species can be manifold: Most obvious is direct competition with native species, an increasing abundance in the new environment until a complete replacement of native residents occurs. Alien species may be associated with pathogens and parasites or they are pathogens and parasites, which may transfer onto and affect a new host. If the new host is susceptible to the new pathogen or parasite, a strong reduction in the population of this native species will result or even local extinction is possible: The alien species has thus caused a loss of biodiversity.

Further consequences of an alien and invasive species may concern water flux, e.g. by increasing consumption or contamination. Matter flux (primarily carbon or nitrogen) may be influenced by an altered decomposition of plant litter and wood or via nitrogen-fixating symbionts.

Besides such environmental impacts many alien species cause enormous economic impacts or directly influence human or animal health. Many alien invertebrates, especially insects, cause great damage to agriculture and forestry. Many protozoans and "worms" are human parasites and many insects are vectors of bacteria and viruses which cause numerous serious diseases. Today, such super-pests are cosmopolitan but this term camouflages that in most parts of the world, where they occur today, they are alien and invasive species. In the case of humans and on a global scale, they cause millions of fatalities each year.

Not all alien species are invasive and it is in fact strange to observe some aliens for years and decades at a given location that show no signs of obvious spread. The process from the first introduction of an alien species into a new environment until aggressive invasiveness is characterised by several steps and an alien species may fail at each of these steps. After a first introduction, it is decisive if the new environment fits the need of this species. Usually, if the number of individuals is low, the species has a rather small chance of establishing reproducing populations. But the higher this number is or the longer the introduction process lasts, the better the chances are of the new species establishing. Establishment means survival and reproducing viable populations on the spot, which is called the lag phase. The next step is when the alien species produces a surplus reproduction which allows modest migration. In this period an alien species may adapt in some way to its new environment and this phase is often called bottleneck with a transition from the lag phase to the log phase. In the log phase, the alien species reaches more suitable habitats which allow a higher reproduction. By continuous population growth, the population pressure on adjacent areas is increased and impacts on the ecosystem also become evident and increase: now the alien has become invasive. Observing an alien in a non-invasive status does not mean that it will not become invasive (and thus can be tolerated as harmless), it rather means that it is not (yet) invasive but it could be just a matter of time until it becomes invasive. Changes in land use or climate can also enable previously harmless alien species to begin to spread uncontrollably and become invasive.

Roughly 50 years ago, the British ecologist Charles Elton published his *Ecology of invasions by animals and plants*, already then warning of the danger arising from alien and invasive species: "The whole matter goes far wider than any technological discussion of pest control, though many of the examples are taken from applied ecology. The real thing is that we are living in a period of the world's history when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature. We are seeing huge changes in the natural population balance of the world" (Elton 1958). Elton was among the first to describe the typical pattern of an alien species establishment. That what he called "biological explosion" is today known as biological invasion (Nentwig 2008). He was also among the first to investigate why and how species were dispersed by human activities and he analysed even then the negative impacts of species in a new environment. He was among the first to ask how this could be prevented.

Astonishingly, the hazards provoked by alien species did not cause that much concern among scientists, nor did it attract public awareness as much as would have been expected (Hulme et al. 2009). However, the ultimate reason for the loss of more than 5% of the world GNP, one main reason for the loss of biodiversity, for millions of human deaths, and for the loss of more than 20% of the world's food production cannot be ignored.

Prevention has multiple faces leading from raising awareness in the public to better scientific knowledge and documentation. More regulations and guidelines must to be put into place and existing regulations must be applied more consequently and carefully. Further import of aliens should be avoided; current aliens should be confined, controlled and even eradicated. We must face this challenge through changes in world trade, adoption of regional strategies and regulations, improved national legislation and better administration, but also through improvements in general education and awareness and the improved spread of information through the media.

Science is also absolutely required in order to manage the problems that alien species may cause. How can they be detected and identified? What is their population development and habitat requirement? What is their impact in the invaded area? How can they be controlled, reduced, or eradicated? How can we predict which species that may become invasive and how can we manage the risks? For most alien species there are yet no answers to most of these questions. Even the seemingly simple question on the number of alien species in Europe could not been answered a few years ago.

Therefore, the European Commission, in its Sixth Framework Programme, launched a call for an inventory of alien invasive species. The successful application was awarded to a consortium of leading researchers of biological invasions in Europe, drawn from 19 institutions across 15 countries. The resulting project, DAISIE (Delivering Alien Invasive Species Inventories for Europe), was launched in February 2005 and ran for three years, until the end of January 2008.

The main objectives of DAISIE were (1) the creation of an inventory of all known alien species in the European terrestrial, freshwater and marine environments; (2) to describe the worst alien and invasive species in Europe and to describe their envi-

ronmental, economic and health risks impacts; and (3) to compile a directory of experts on alien species. Since February 2008, the DAISIE information system is freely available at http://www.europe-aliens.org. In 2009 a condensed version of the DAISIE information system was published in a Handbook of Alien Species in Europe (DAISIE 2009).

Invertebrates, and among them arthropods, comprise the largest proportion of alien animals and are of pronounced importance, e.g. in agriculture, horticulture and forestry, the cultural environment and for human and animal health. Despite the far reaching and serious effects that alien invertebrate species have on biological diversity, health and society, knowledge of their effects and potential risks is still insufficient. This knowledge is crucial for managing the risks involved with the transfer of species both intentionally and unintentionally. Based on the expert knowledge of 78 scientists from 25 European countries, this book will present for the first time in a comprehensive way the alien arthropods having established in Europe, including detailed information on taxonomy, pathways, invaded habitats, impacts and trends. The book will focus on the 1590 terrestrial arthropod species presently identified as aliens *to* Europe. They will be presented by taxonomic rank. For each group, additional information will be provided about the species alien *in* Europe whenever the actual status of such species can be considered as ascertained with regard to the difficulties mentioned above. Moreover, the 80 most important alien invasive species are presented in factsheets in more detail in order to raise awareness and provide information upon which to base measures to prevent and control these species.

References

DAISIE (2009) *Handbook of alien species in Europe*. Dordrecht: Springer. 399 pp.

Elton CS (1958) The ecology of invasions by plants and animals. London: Methuen & Co. Ltd. 181 pp.

Hulme PE, Pyšek P, Nentwig W, Vilà M (2009) Will threat of biological invasions unite the European Union? *Science* 324: 40–41.

Nentwig W (Ed) (2008) *Biological Invasions. Ecological Studies* 193. Heidelberg: Springer. 441 pp.

Petersen KS, Rasmussen KL, Heinemeier J, Rud N (1992) Clams before Columbus? *Nature* 359: 679.